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[Title of the Invention] METHOD AND APPARATUS FOR MANUFACTURING LIQUID CRYSTAL DISPLAY CELL

[Abstract]

[Object] An object of the present invention is to provide a method of manufacturing a liquid crystal display cell used for a display apparatus capable of manufacturing a liquid crystal to be accurately injected into the cell with a good reproducibility of a weight of the liquid crystal and simply and practically implementing a dropping method in comparison to a conventional injection method which has been mainly used.

[Solving Means] A weight (hereinafter, referred to as a before-dropping substrate weight) of an electrode substrate 11 on which a liquid crystal 14 is to be dropped and attached is measured by a first weight measuring unit 15; the data is stored in a control unit 16; a weight (hereinafter, referred to as a net required liquid crystal amount) to be charged is attached by using a first liquid crystal ejecting dropping unit 17; a weight of the electrode substrate 11 on which the liquid crystal 14 is attached is measured by a second weight measuring unit 18; a difference between the before-dropping substrate weight data stored in the control unit 16 and the weight measured by the second

weight measuring unit 18 is calculated; and an insufficient liquid crystal amount is attached by using a second liquid crystal ejecting dropping unit 22, so that a constant net required liquid crystal amount can be attached on the electrode substrate 11.

[Claims]

[Claim 1] A method of manufacturing a liquid crystal display cell, comprising steps of:

forming a gap formation sealing member in a shape of square on an electrode surface of at least one of two electrode substrates which has a surface on which a transparent electrode is formed and another surface on which a polarizing plate is formed;

measuring a weight of the electrode substrate by using a first weight measuring unit and storing the weight as a before-dropping substrate weight in a control unit;

dropping and attaching an amount not exceeding a required charging liquid crystal amount stored in the control unit within a frame surrounded with the square sealing member on the electrode substrate by using a first liquid crystal ejecting dropping unit;

measuring a weight of the electrode substrate by using a second weight measuring unit and storing the weight as an after-dropping substrate weight in the control unit;

calculating a net liquid crystal amount by subtracting the before-dropping substrate weight from the after-dropping substrate weight;

if the net weight liquid crystal amount is insufficient with respect to the required charging amount previously stored in the control unit, dropping the insufficient amount by using a second liquid crystal ejecting dropping unit; and

attaching the electrode substrate to the opposite electrode substrate.

[Claim 2] An apparatus for manufacturing a liquid crystal display cell, comprising:

a first weight measuring unit for measuring a weight of an electrode substrate on which a transparent electrode and a gap formation sealing member are formed;

a first liquid crystal ejecting dropping unit for dropping and attaching the liquid crystal on the electrode substrate;

a second weight measuring unit for measuring a weight of the electrode substrate on which a liquid crystal is attached;

a control unit for calculating data from the first and second weight measuring units to indicate a required charge amount of the liquid crystal for the electrode substrate;

a second liquid crystal ejecting dropping unit for dropping and attaching the liquid crystal on the electrode

substrate based on the indication of the control unit; and

a transfer unit for sequentially transferring the electrode substrate to components.

[Claim 3] An apparatus according to Claim 2, wherein the second liquid crystal ejecting dropping unit drives a piston in a syringe with a ball screw rotating by a pulse motor, so that a fine ejection of the liquid crystal is performed.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method of manufacturing a liquid crystal display cell used as a thin, light-weighted, low-power consumptive display, and more particularly, to a method of filling a liquid crystal into a liquid crystal display cell and an apparatus

[0002]

[Description of the Related Art]

A liquid crystal display device is a thin, light-weighted, low-power consumptive display device. Recently, the liquid crystal display device has been widely used for a small-sized display device such as a watch and a calculator, a large-sized display device such as a PC and a word processor, and a high-accuracy large-sized display device such as a workstation.

[0003]

In general, as shown in a cross sectional view of Fig. 5, the liquid crystal display device comprises two transparent electrode substrate 2a and 2b facing each other to form a gap; transparent electrodes 1a and 1b are patterned on respective surfaces of the transparent electrode substrates 2a and 2b; a liquid crystal 3 interposed between the two transparent electrodes 1a and 1b; a spacer defining the gap; a sealing member 4 for sealing circumferential portions thereof; and polarizing plates 5a and 5b disposed on outer surfaces of the transparent electrode substrate 2a and 2b.

[0004]

Methods of interposing the liquid crystal 3 between the two transparent electrodes 1a and 1b are as follows. As shown in a perspective view of Fig. 6, there is an injection method. In the injection method, sealing members 4 having a liquid crystal injection inlet 4a at an edge thereof are disposed on one electrode substrate 2a. Next, another electrode substrate 2b are adhered and fixed with the facing electrode substrate 2a to form sandwich cell containers. Next, the resulting product is cut and divided in units of a predetermined size. Next, the liquid crystal 3 is injected through the liquid crystal injection inlet 4a into the vacuum container. Next, the liquid crystal injection inlet 4a is sealed with an adhesive.

[0005]

As shown in a perspective view of Fig. 7, there is a dropping method. In the dropping method, sealing members 4 having no liquid crystal inlet are disposed on the electrode substrate 2a. Next, a required amount of the liquid crystal 3 is sequentially dropped from a distal end of a thin pipe by using a pipette or syringe. Next, another electrode substrate 2b are adhered and fixed with the facing electrode substrate 2a.

[0006]

[Problems to be Solved by the Invention]

In the conventional injection method, the facing electrode substrate 2a and 2b are attached and fixed by using the sealing member 4 to form a container having a sandwich cell structure; the liquid injection inlet is immersed into the liquid crystal 3 in liquid crystal storage pool in a vacuum chamber; and the liquid crystal 3 is injected by using a capillary effect and increasing and reducing a pressure. Various methods are disclosed in Japanese Unexamined Patent Application Nos. Sowha 58-37527, Sowha 58-40726, and Heisei 1-28363. However, in the methods, loss of the liquid crystal material attached on the edge of the liquid crystal injection inlet 4a occurs. In addition, after the molding, there is a need for a process of cleaning the liquid crystal 3 attached thereon.

[0007]

In addition, when the pressure increasing and reducing processes are repeatedly performed, too much liquid crystal injection time is taken. Particularly, in case of a large-sized panel, the time may be longer than 60 minutes.

[0008]

In addition, in case of a recent large-sized panel, there is need to improve attachment accuracy for the facing electrode substrate 2a and 2b in consideration of display dots and display quality. Therefore, a pressing means is needed to fixing the sealing member 4.

[0009]

In addition, after the liquid crystal is injected, before the liquid crystal injection inlet 4a is molded, there is a need to discharge an surplus amount of the injected liquid crystal 3 by using a pressing means in order to ensure a proper gap and uniformity of the gap which is an principal factor for the display quality, as described above. In order to solve the problems, various approaches have been proposed, there are still problems in that detail production management is required and the number of production processes increases.

[0010]

In order to solve the aforementioned problems, various approaches are proposed in Japanese Unexamined Patent

Application Nos. Sowha 49-79541, Sowha 55-6881, Sowha 55-6882, Sowha 61-55625, Sowha 60-229104, and Sowha 62-10596.

[0011]

However, in the dropping method, a layer of the sealing member 4 such as an adhesive is formed on a circumferential portion of a display region of the facing electrode substrates 2a and 2b having transparent electrodes 1a and 1b; the liquid crystal 3 is dropped inside of the circumferential portion; and then, pressing and curing processes are performed. The gap between the facing electrode substrates 2 of the general liquid crystal panel and 2' have a thinness of several μm, but the required charge liquid crystal amount 3 in the gap volume surrounded by the gap and sealing member 4 is too small. In addition, since the gap volume charged with the liquid crystal 3 may change due to error in the thickness of the sealing member 4, it is necessary to dropping an accurately measured liquid crystal amount. Therefore, it is difficult to manufacture the liquid crystal display apparatus in terms of the dropping amount. As a result, the liquid crystal display apparatus manufactured by using the dropping method is not practically provided.

[0012]

An object of the present invention is to provide a method of manufacturing a liquid crystal display cell used

for a display apparatus capable of manufacturing a liquid crystal to be accurately injected into the cell with a good reproducibility of a weight of the liquid crystal and simply and practically implementing a dropping method in comparison to a conventional injection method which has been mainly used.

[0013]

[Means for Solving the Problems]

In order to solve the aforementioned problems, according to an aspect of the present invent, there is provided a method of manufacturing a liquid crystal display cell, comprising steps of: forming a gap formation sealing member in a shape of square on an electrode surface of at least one of two electrode substrates which has a surface on which a transparent electrode is formed and another surface on which a polarizing plate is formed; measuring a weight of the electrode substrate by using a first weight measuring unit and storing the weight as a before-dropping substrate weight in a control unit; dropping and attaching an amount not exceeding a required charging liquid crystal amount stored in the control unit within a frame surrounded with the square sealing member on the electrode substrate by using a first liquid crystal ejecting dropping unit; measuring a weight of the electrode substrate by using a second weight measuring unit and storing the weight as an

after-dropping substrate weight in the control unit; calculating a net liquid crystal amount by subtracting the before-dropping substrate weight from the after-dropping substrate weight; if the net weight liquid crystal amount is insufficient with respect to the required charging amount previously stored in the control unit, dropping the insufficient amount by using a second liquid crystal ejecting dropping unit; and attaching the electrode substrate to the opposite electrode substrate.

[0014]

[Operation] According to the method of the present invention, it is possible to accurately manage a net required liquid crystal amount for individual electrode substrates in a liquid crystal display apparatus. Unlike a conventional method, without dropping of an accurately-measured liquid crystal amount, it possible to drop an optimal liquid crystal amount depending on a situation before the dropping process. Therefore, it is possible to improve reproducibility of dropped liquid crystal amount, and detail management is not required. The dropping method can be practically implemented.

[0015]

[Embodiments]

Now, a method and apparatus for manufacturing a liquid crystal display cell according to an embodiment of the

present invention.

[0016]

In Fig. 1, (A) to (G) are a series of manufacturing process views illustrating a method of manufacturing a liquid crystal display cell according to the present invention. Fig. 2 is a perspective view illustrating an apparatus for manufacturing the liquid crystal display cell according to the embodiment of the present invention. Fig. 3 is a conceptual view of a system of a controller according to the embodiment of the present invention. Fig. 4 is a cross sectional view illustrating a second liquid crystal ejecting dropping unit according to the embodiment of the present invention.

[0017]

Firstly, as shown in FIGS. 1(A) and 1(B), glass electrode substrates 11 and 12 subject to a liquid crystal alignment process are prepared. Here, transparent electrode patterns (not shown) are formed on the electrode substrates 11 and 12. A sealing material 13 is printed on one electrode substrate 11 by using a screen printing method. Next, as shown in FIG. 1(C), a weight of the electrode substrate 11 on which the sealing material 13 is printed is measured by using a first weight measuring unit 15, and the measuring data is stored as before-dropping substrate weight in a control unit 16.

[0018]

Next, as shown in FIG. 1(D), some droplets of liquid crystal 14 are dropped as first dropping process on two portions surrounded with the sealing material 13 of the electrode substrate subject to the weight measuring process by using a micro syringe a first liquid crystal ejecting dropping unit 17.

[0019]

If the dropping position of the liquid crystal 14 is too close to the sealing material 13 the liquid crystal 14 may flow to the sealing member before the electrode substrates 11 and 12 are attached to each other. Therefore, when the electrode substrates 11 and 12 are attached to each other, the sealing member may be disconnected, or the liquid crystal 14 may extend outside the sealing member. On the other hand, if the number of the droplets of the liquid crystal 14 is too small, there is non-uniformity in a thickness of the liquid crystal layer in both of the dropping position and un-dropping position. Therefore, a large number of droplets of the liquid crystal 14 are preferably dropped if possible. In addition, the accuracy of the liquid crystal amount is directly associated with the accuracy of the gap, so that an dropped amount of the liquid crystal is preferably slightly less than a net required liquid crystal amount. This is because there is no method

of avoiding a surplus amount of the liquid crystal 14 (excedding the net required liquid crystal amount attached to the electrode substrates 11 and 12) from the electrode substrates 11 and 12 with a high accuracy and without loss of the liquid crystal.

[0020]

Next, as shown in FIG. 1(E), a weight of the electrode substrate 11 where the liquid crystal 14 is dropped is measured by using a second weight measuring unit 18, and the measuring result is stored as an after-dropping substrate weight in the control unit 16.

[0021]

The control unit 16 is constructed with a system shown in FIG. 3. The control unit 16 calculates the net liquid crystal amount 33 (substantially attached on the electrode substrate 11) by subtracting the after-dropping substrate weight from the before-dropping substrate weight. In addition, an insufficient amount of the net required liquid crystal amount is calculated from a difference from the net required liquid crystal amount 34 stored in the control unit 16. Next, a second dropping amount 37 is indicated in accordance with an ejecting resolution 36 of the second liquid crystal ejecting dropping unit 22.

[0022]

Next, as shown in FIG. 1(F), some droplets of the

liquid crystal 14 is dropped as a second liquid crystal dropping process on the electrode substrate 11 (where the first liquid crystal dropping process is performed). Next, as shown in FIG. 1(G), the electrode substrate 11 is attached to the opposite electrode substrate 12.

[0023]

In addition, in the embodiment, in order to improve the accuracy of ejection of the liquid crystal 14, as shown in FIG. 4, a micro syringe is used to eject the liquid crystal 14. In the micro syringe, a piston 72 is provided to an inner portion of the syringe 71; the piston 72 is directly connected to a ball screw 73 and a pulse motor 74. By moving the piston 7, the liquid crystal charged in the inner portion of the syringe 72 is ejected through a thin pipe 75 mounted on a distal end of the syringe 71.

[0024]

A detailed apparatus for implementing the method described above is shown in FIG. 2. In FIG. 2, reference numeral 21 denotes a conveyer for picking out the electrode substrate 11 (that is, the before-dropping substrate) from a previous apparatus (such as a sealing printing apparatus) before the liquid crystal charge process. Reference numeral 15 denotes a first weight measuring unit for measuring a weight of the before-dropping substrate picked out from the previous process apparatus. Reference numeral 17 denotes a

first liquid crystal ejecting dropping unit described above with reference to FIG. 4. Reference numeral 18 denotes a second weight measuring unit for measuring a weight of the after-dropping substrate. Reference numeral 22 denotes a second liquid crystal ejecting dropping unit, which enables each component to process one sheet of electrode substrate. Reference numeral 26 denotes a transfer unit for transferring the electrode substrate 11 to the components. In order to improve productivity, the transfer unit 26 can transfer the electrode substrate 11 at one time from the conveyer 21 to the first weight measuring unit 15, from the first weight measuring unit 15 to the first liquid crystal ejecting dropping unit 17, from the first liquid crystal ejecting dropping unit 17 to the second weight measuring unit 16, from the second weight measuring unit 16 to the second liquid crystal ejecting dropping unit 22.

[0025]

In addition, in the apparatus according to the embodiment, the liquid crystal dropping is performed in a time of 40 seconds for each electrode substrate 11, as a reference.

[0026]

In addition, in the embodiment, the liquid crystal 14 may be TN liquid crystal material, STN liquid crystal material, and FLC liquid crystal material, but not limited

thereto. The liquid crystal driving method may be an active matrix type or a simple matrix type, but not limited thereto.

[0027]

In addition, the method for firstly attaching the liquid crystal 14 on the electrode substrate 11 may be a liquid crystal coating method using a screen printing process or a blade process, but not limited thereto. In addition, the attached amount may be calculated from a difference between the before-attachment and after-attachment electrode substrate weights, and a second liquid crystal ejecting dropping unit 22 for providing an insufficient amount may be provided in order to obtain the same effect as those of the embodiment of the present invention.

[0028]

[Effects]

As described above, according to a method and apparatus for manufacturing a liquid crystal display cell of the present invention, a net required liquid crystal amount to be charged into the cell of the liquid crystal display device can be accurately controlled in an order of mg at individual substrates, so that it is possible to manufacture the liquid crystal display cell with a high yield. As a result, in comparison to a conventional injection method, the following effects can be obtained.

(1) An injection molding process is unnecessary, so that the number of processes can be reduced. Therefore, production processes can be optimized, and lead time can be shorted.

(2) Loss of a highly expensive liquid crystal material which is attached around during a liquid crystal injection process cannot occur, so that it is possible to reduce production cost.

(3) In addition, it is possible to easily control liquid crystal amount to be sealed (which is a difficult problem in a conventional dropping method). In addition, this can be obtained by performing a single one process in a short time.

Therefore, it is possible to effectively charge liquid crystal by using the dropping method.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 illustrates perspective views for explaining a series of processes in a method of manufacturing a liquid crystal display cell according to an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a perspective view illustrating an apparatus for manufacturing the liquid crystal display cell according

to the embodiment of the present invention.

[Fig. 3]

Fig. 3 is a conceptual view of a system of a controller according to the embodiment of the present invention.

[Fig. 4]

Fig. 4 is a cross sectional view illustrating a second liquid crystal ejecting dropping unit according to the embodiment of the present invention.

[Fig. 5]

Fig. 5 is a cross sectional view illustrating a construction of a liquid crystal display device.

[Fig. 6]

Fig. 6 is a perspective view for explaining a conventional method (an injection method) of manufacturing a liquid crystal display device.

[Fig. 7]

Fig. 6 is a perspective view for explaining a conventional method (a dropping method) of manufacturing a liquid crystal display device.

[Reference Numerals]

11: electrode substrate

12: electrode substrate

13: sealing member

14: liquid crystal

15: first weight measuring unit

16: controller

17: first liquid crystal ejecting dropping unit

18: second weight measuring unit

21: conveyer

22: second liquid crystal ejecting dropping unit

26: transfer unit

31: before-dropping substrate weight data

32: after-dropping substrate weight data

33: net liquid crystal weight

34: net required liquid crystal amount

35: insufficient amount of net required liquid crystal amount

36: ejecting resolution of liquid crystal ejecting dropping unit

37: dropped amount

71: syringe

72: piston

73: ball screw

74: pulse motor

75: thin pipe